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INTERPRETATION OF ELECTRO-GLOTTOGRAPHIC RECORDINGS*

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The general interpretation of the electro-glottographic wave form states that a glottal closure results in a decrease of the electrical resistance, and that this decrease depends on the degree of closure. The more firm the closure (i.e. the greater the area of contact between the vocal folds), the lower is the electrical resistance. An alternative hypothesis (Loebell 1981[1], Smith 1981 and 1982) explains the wave forms as electrical resistance curves showing the summation of the acoustic compression of the muscular tissue above glottis and below glottis. The sound wave compresses the tissue according to the variations in sound pressure, and as the sound pressure wave above glottis is 180° out of phase relative to the sound pressure wave below glottis, the resulting compression of the tissue at the level of glottis can be expressed as the summation of the compression below and above glottis, which in turn is assumed to be proportional to the summation of the sound pressure levels above and below glottis.

As this hypothesis sounded interesting, I wanted to test it, and I did it by means of glottography in helium, which has a velocity of sound three times the sound velocity in air.

Simultaneous recordings of electroglottography and two accelerometers positioned just above and just below glottis in air and in helium were made.

Figure 1 shows the three curves recorded during phonation of a sustained /i:/ with a sound pressure level of 75 dB measured 40 cm from the mouth and with a fundamental frequency of approximately 130 Hz. The upper curve registers changes in sound

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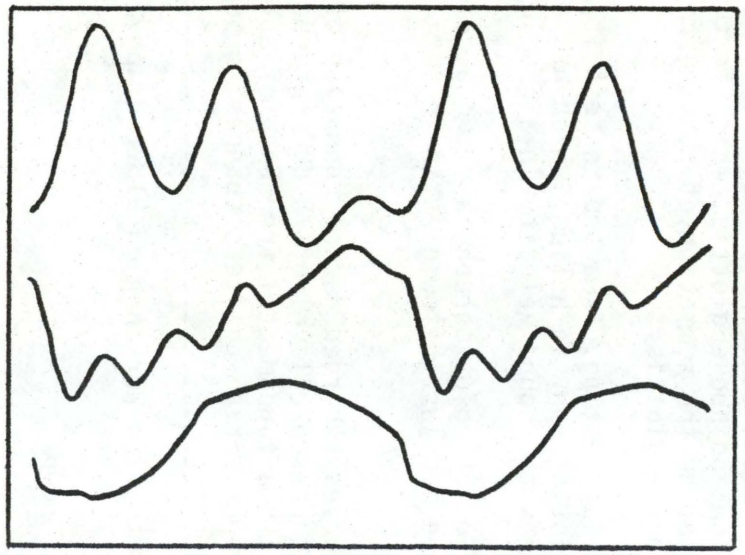

Figure 1

Recording in air:

A: Sound pressure above glottis
B: Sound pressure below glottis
A,B: Increased pressure indicated by downward deflection of the curve
C: Electro-glottogram.
Increased electrical resistance indicated by upward deflection of the curve.

A

B

C

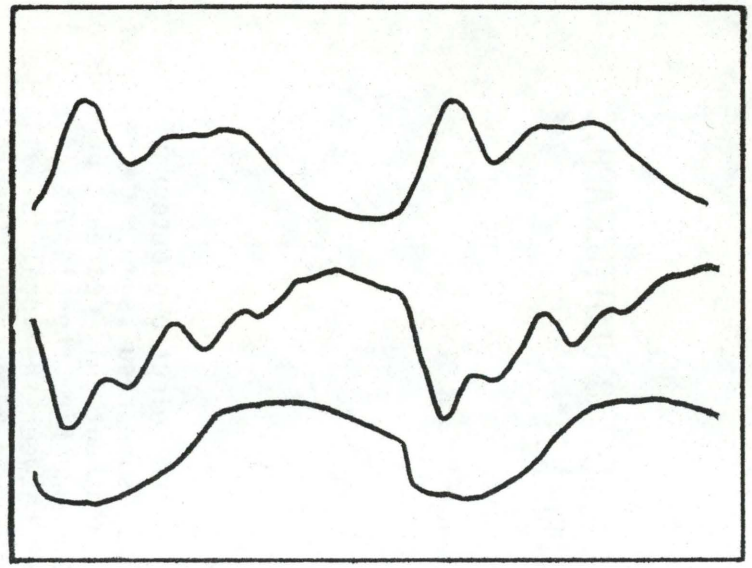

Figure 2

Same traces as shown in figure 1, but recorded in helium:

A: Sound pressure above glottis
B: Sound pressure below glottis
A,B: Increased pressure indicated by downward deflection of the curve
C: Electro-glottogram.
Increased electrical resistance indicated by upward deflection of the curve.

pressure recorded from the neck just above larynx, the middle curve registers changes in sound pressure recorded from the neck below larynx, and the bottom curve shows the electro-glottographic wave form.

According to the alternative hypothesis the electro-glottogram should represent some sort of combination or sum of the two upper curves. If this is correct, then the wave form of the electro-glottogram must change if the wave form of one of the two upper curves is altered. In order to test that, a phonation of a sustained /i:/ vowel was made with the vocal tract above glottis filled with helium.

Figure 2 shows the recording made with a helium-filled vocal tract. The helium was introduced in the lower part of the pharyngeal cavity through a flexible plastic tube. The phonation started with an air-filled vocal tract which resulted in the voice quality depicted in figure 1, then helium was introduced keeping the phonatory and articulatory positions unchanged. When maximum distortion of the sound quality was obtained, the recordings in figure 2 were made.

It is seen in figure 2 that the upper curve representing the sound pressure wave above glottis is drastically changed without any important changes in the middle curve representing the sound pressure below glottis. This is in accordance with what could be expected, since the velocity of sound is changed above but not below glottis.

However, the most important observation is that the wave form of the electro-glottogram does not show any appreciable changes. This suggests that the electro-glottogram is not (to any considerable extent) sensitive to the compression of the tissue above glottis. On the contrary, the electro-glottogram seems to be rather constant even though the pharyngeal sound pressure wave is changed drastically.

A good deal of glottograms have been made in connection with this pilot study, but all the wave forms showed to be relatively insensitive to the acoustic sound pressure, even at a high voice effort.

This paper is to be considered only as a note on ongoing research. In a more definitive analysis the position of the electro-glottographic skin electrodes must, of course, be monitored very accurately, and the variations in the glottogram with alternative placings must be examined (Lecluse 1977). The approximate position of the electrodes in the present experiment appears from figure 3.

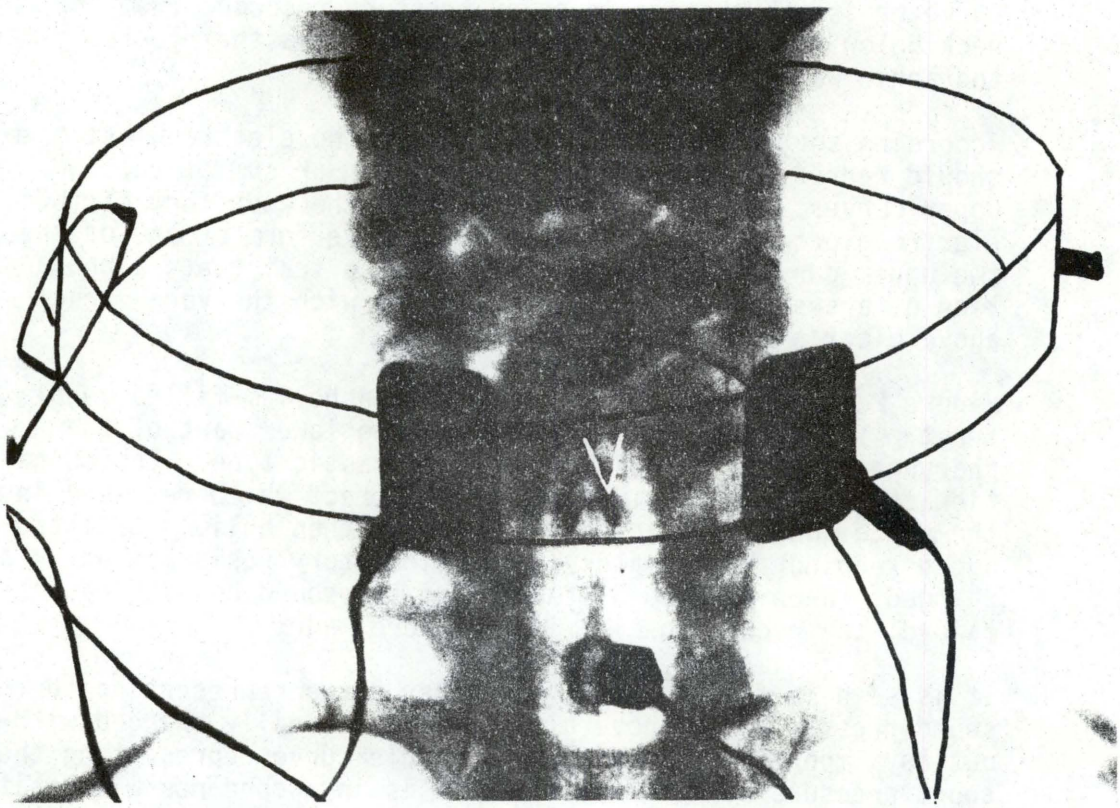

Figure 3

X-ray photo of subject BFJ. The photo is tilted approximately 20^0.

(1) The position of the two accelerometers above the thyroid cartilage and below the cricoid cartilage. The upper accelerometer is seen in a position which is further tilted relative to the vertical plane, because the neck surface is sloping at the point of fixation.

(2) The position of the skin electrodes of the glottograph positioned by the neck belt (which is drawn by hand on the X-ray photo) at the same horizontal level as the lower edges of the arytenoid cartilages.

(3) Rima glottidis is drawn by hand with white ink.

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NOTE

1. Cf. Loebell 1981: "*1. Schalldruckänderungen:* Smith weist darauf hin, dass die Technik eine akustische Registrierung und eine Spektralanalyse erlaubt. *2. Luftdruckänderungen:* Smith macht darauf aufmerksam, dass der Abfall der Impedanz am Anfang der phonatorisch-glottographischen Periode zweigeteilt sein kann und auf 2 Faktoren zurückzuführen ist: -- 1. auf die Zunahme des Druckes im Gewebe und 2. auf den Anfang der akustischen Periode."

Comment from Professor Svend Smith:

I never explained the wave forms of the so-called glottograms as a summation of acoustic compression of tissue above glottis and below glottis, neither at the symposium in Hannover 1981 (Loebell 1981) nor in later publications.